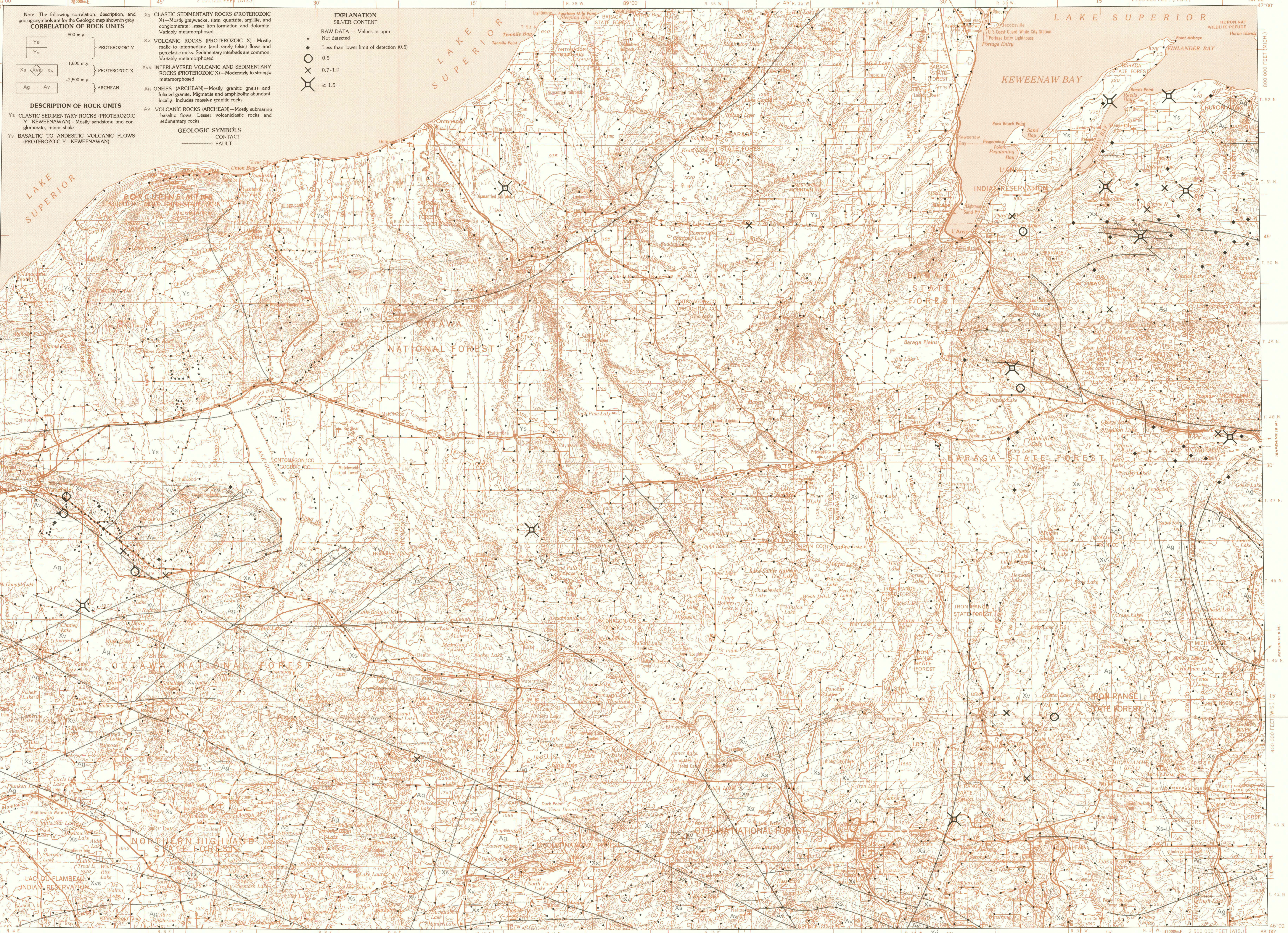

Base from U.S. Geological Survey 1958–67
100,000-foot grids based on Michigan coordinate system, north zone and Wisconsin coordinate system, north zone
10,000-meter Universal Transverse Mercator grid ticks, zone 16

Geology simplified from Cannon, 1984

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVAL 50 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1984—G83023

INTRODUCTION

This map is part of a folio of 1:250,000-scale maps of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, prepared as a project of the Conterminous United States Mineral Assessment Program. A list of maps (U.S. Geological Survey Miscellaneous Investigations Series Maps I–1360–A–N) for the complete folio follows.

MAP	
I–1360–A	Mineral resources of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by W. F. Cannon.
I–1360–B	Bedrock geologic map of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by W. F. Cannon.
I–1360–C	Surficial geologic map of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by W. L. Peterson.
I–1360–D	Structural and tectonic map of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by W. F. Cannon.
I–1360–E	Bouguer gravity anomaly map and geologic interpretation of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by J. S. Klasner and W. J. Jones.
I–1360–F	Aeromagnetic map of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by E. R. King.
I–1360–G	Metamorphic map of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by Karen Wier.
I–1360–H	Copper distribution in B-horizon soils in the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by H. V. Alminas, J. D. Hoffman, and R. T. Hopkins.
I–1360–I	Chromium distribution in B-horizon soils in the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by H. V. Alminas, J. D. Hoffman, and R. T. Hopkins.
I–1360–J	Cobalt distribution in B-horizon soils in the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by J. D. Hoffman, H. V. Alminas, and R. T. Hopkins.
I–1360–K	Nickel distribution in B-horizon soils in the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by J. D. Hoffman, H. V. Alminas and R. T. Hopkins.
I–1360–L	Silver distribution in B-horizon soils in the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by R. T. Hopkins, H. V. Alminas, and J. D. Hoffman.
I–1360–M	Molybdenum distribution in B-horizon soils in the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by R. T. Hopkins, H. V. Alminas, and J. D. Hoffman.
I–1360–N	Interpretive geochemical map of the Iron River 1° x 2° quadrangle, Michigan and Wisconsin, by H. V. Alminas, J. D. Hoffman, R. T. Hopkins.

The field, analytical, and interpretational work pertaining to this map was conducted in 1978–80. The analytical data were entered and stored in the U.S. Geological Survey computer storage system (RASS), (VanTrump and Miesch, 1977). A table format listing of the data was published in 1981 (Hopkins, 1981).

AREA DESCRIPTION

The Iron River 1° x 2° quadrangle encompasses the area bounded by 46°–47° latitude and 88°–90° longitude. It includes most of the western part of the Michigan Upper Peninsula as well as a segment of northern Wisconsin in its southwestern corner. Of the 17,222 km^2 (6,624 mi^2) delineated by these boundaries, some 15,454 km^2 (5,944 mi^2) is land surface; Lake Superior encompasses 1,768 km^2 (680 mi^2).

The climate within this region is cool and moist. Long severe winters and short summers with moderate temperatures are characteristic. The average annual precipitation is approximately 86 cm (34 in). Topographically, the region as a whole is a highland and headwater drainage area although locally the topography is quite variable. It has been greatly modified by repeated glacial action, which generally rounded and leveled the high areas and scoured and then filled the valleys.

The entire area is covered by a wide range of glacial materials ranging in thickness from 0 through >90 m (>300 ft), probably averaging in the 20–30 m (70–100 ft) range.

SAMPLING DESIGN

Previous studies (Alminas, 1975) in areas of similar climatic, topographic, and geologic setting have indicated that B-horizon soils can serve as an effective sample medium in an environment exemplified by the Upper Peninsula of Michigan. Also, this sample medium provides operational advantages in that samples can be collected rapidly and easily throughout broad areas with a relatively uniform distribution of sample sites.

For this study, B-horizon soils were collected at 3,156 localities, or at an approximate density of one sample per 5.1 km^2 (2 mi^2). An attempt was made to obtain as uniform a distribution of sample sites as possible, along roads, along rivers and lake shores, and in remote areas (accessible by helicopter). Wherever possible, only seemingly undisturbed soils were sampled. In some agricultural areas, however, it was impossible to avoid sampling in cleared fields.

SAMPLE COLLECTION

Samples were collected in 1978 and 1979 by two sample collectors working a six-week period in May and June and a four-week period in September of each year.

The B-horizon soil samples were collected at a depth range of 7.6 to 71 cm (3–28 in.), although the great majority were collected at a depth between 30.5 cm and 43 cm (12–17 in.). Approximately 1/2 kg (1 lb) of soil was collected at each site, using an impact-type post-hole digger and a small crowbar. The samples were stored in Kraft[1] paper bags. The following information (primarily visually determined) pertaining to the soil and site setting was coded at each location:

1. Slope at sample site
2. Depth at which sample was collected
3. A-horizon thickness
4. Soil color
5. Soil moisture content
6. Soil organic content
7. Soil clay content
8. Soil silt content
9. Soil sand content
10. Angularity of fine fragments
11. Soil pebble content
12. Soil cobble content

Several 5.0-kg (11 lb) B-horizon soil samples were collected at selected sites for heavy-mineral separation.

[1]Use of commercial trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

SAMPLE PREPARATION

The soil samples were oven-dried overnight at 100°C in the original paper bags. Extremely clay rich samples were disaggregated in a crusher, using a wide jaw setting. All of the soils were then sieved through an 80-mesh (177-micron opening) sieve, and an 84-g (3-oz) sample of the fine fraction was saved for analysis.

The 5-kg B-horizon samples were washed, panned, and dried. The remaining light-mineral fraction was removed by Bromoform (sp. gr. 2.85) separation.

ANALYTICAL METHODS

Element concentrations were determined by a semiquantitative spectrographic method described by Grimes and Marranzino (1968). Results of these spectrographic analyses are reported within geometric intervals having the boundaries of 1,200, 830, 560, 380, 260, 180, 120, all in ppm, but are shown in the histograms by approximate geometric midpoints, such as 1,000, 700, 500, 300, 200, 150, and 100 (Mosier, 1972). Precision of a reported value is approximately plus or minus one interval at the 68 percent confidence level, or plus or minus two intervals at the 95 percent confidence level (Motooka, 1976). Table 1 shows the elements analyzed for and individual detection limits.

Table 1.—*Elements analyzed for and limits of detection*

Element	Unit of measure	Limit of detection
Fe	percent	0.5
Mg	percent	.02
Ca	percent	.05
Ti	percent	.002
Mn	ppm	10
Ag	ppm	.5
As	ppm	200
Au	ppm	10
B	ppm	10
Ba	ppm	20
Be	ppm	1
Bi	ppm	10
Cd	ppm	20
Co	ppm	5
Cr	ppm	10
Cu	ppm	5
La	ppm	20
Mo	ppm	5
Nb	ppm	20
Ni	ppm	5
Pb	ppm	10
Sb	ppm	10
Sc	ppm	5
Sn	ppm	10
Sr	ppm	100
V	ppm	10
W	ppm	50
Y	ppm	10
Zn	ppm	200
Zr	ppm	10
Th	ppm	100

DATA PRESENTATION

The silver data are presented on the map by symbols. All of the sample sites within the map area are shown. The symbols used to represent the various silver content classes are shown in the explanation. An isopleth presentation was omitted on this map because of the low number of cells containing silver values.

The map was plotted by computer, using a mapping program within the STATPAC system (VanTrump and Miesch, 1977).

NATURE AND DISTRIBUTION OF SOILS

Soils are the products of weathering. The nature of a soil is determined by a combination of several factors acting through time within the area of soil formation. Probably the most important of these are:

a. The composition of the parent material
b. The topographic setting (especially slope)
c. The climate
d. The amount of vegetational cover
e. The length of time over which the above factors operated

Within the Iron River 1° x 2° quadrangle, essentially all the parent material was deposited by glaciers or glacial melt water, and it ranges in texture from gravel to clay. The soil textures are variable over the map area and could be important in interpreting soil geochemistry. In figure 1, areas of B-horizon soils that are predominantly clay, silt, or sand are delineated.

Most of the soils with an anomalous silver content are in a predominantly sandy area. However, they constitute but a small faction of sand-rich samples, nearly all of which show no detectable silver.

Topographic setting ranges from flay to hilly; slopes are as great as 40 percent. Slope determines the position of the sample site relative to the water table, an important factor inasmuch as the geochemical patterns within this area are interpreted as being predominantly hydromorphic. A map of the soil moisture conditions found at each sample site is figure 2.

Factors c, d, and e can be considered to be constant throughout the map area.

STATISTICAL DISTRIBUTION OF SILVER IN SOILS

Silver content of the 3,156 B-horizon soils ranges from "not detected" (at 0.5 ppm) through 15 ppm. The table below shows the frequency and percent frequency distributions of the silver values.

ppm Ag	Frequency	Percent frequency
N (0.5)	3,086	97.78
L (0.5)	42	1.33
0.5	6	0.19
0.7	2	0.06
1.0	9	0.29
1.5	4	0.13
2.0	1	0.03
3.0	3	0.10
5.0	0	0
7.0	1	0.03
10.0	1	0.03
15.0	1	0.03

AREAL DISTRIBUTION OF SILVER CONTENT

The detectable silver (≥ 0.5 ppm) in B-horizon soils collected within the Iron River 1° x 2° quadrangle is considered to be anomalous. This limit is based on the frequency distribution of soil silver values.

On this basis 70 (2.3 percent) of the 3,156 sample sites within the map area have anomalous concentrations of silver.

Most of the soils having anomalous silver content were collected in the northeastern corner of the map area. The corresponding sample sites occur over a number of rock types, including granite and the Jacobsville Sandstone. A second cluster of anomalous sites occurs at the extreme western edge of the map area in the Wakefield-Dunham region. Here too, the anomalous sites occur over several rock types including granite through mafic and intermediate volcanics. A third, more scattered cluster occurs in the Liver Lake-Lake Emily area (southeastern corner of the map). As is the case with the other two clusters, no silver content-rock type association can be seen here.

DISCUSSION

The correlation coefficients between silver and the other elements analyzed for are very small, whether tested over the total map area or at specific areas containing clusters of anomalous sample sites. However, certain areal silver associations exist, such as that with high areas of beryllium, niobium, and low areas of strontium and lanthanum. These associations are discussed at greater length by Alminas and others (1984).

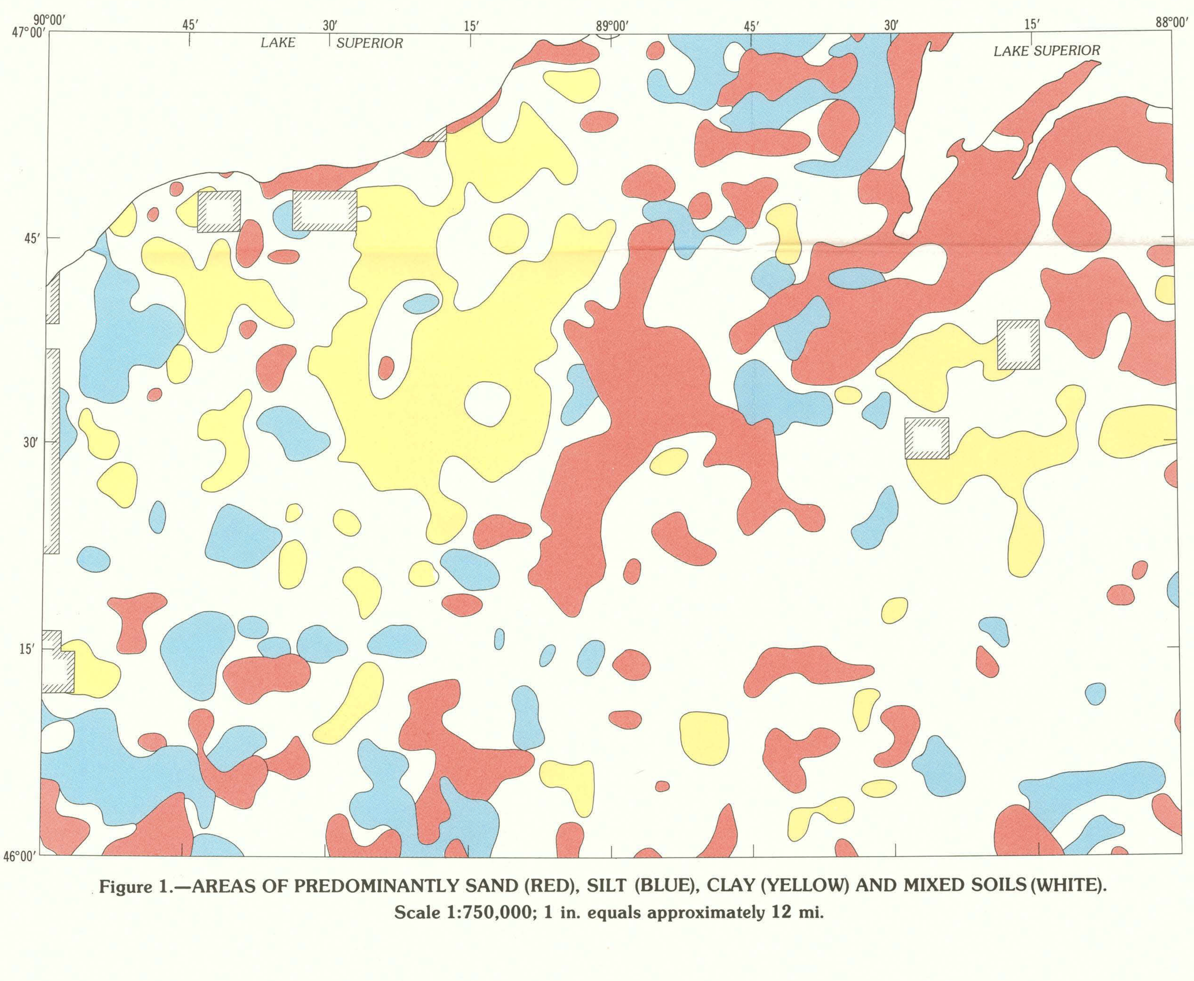

Figure 1.—AREAS OF PREDOMINANTLY SAND (RED), SILT (BLUE), CLAY (YELLOW) AND MIXED SOILS (WHITE). Scale 1:750,000; 1 in. equals approximately 12 mi.

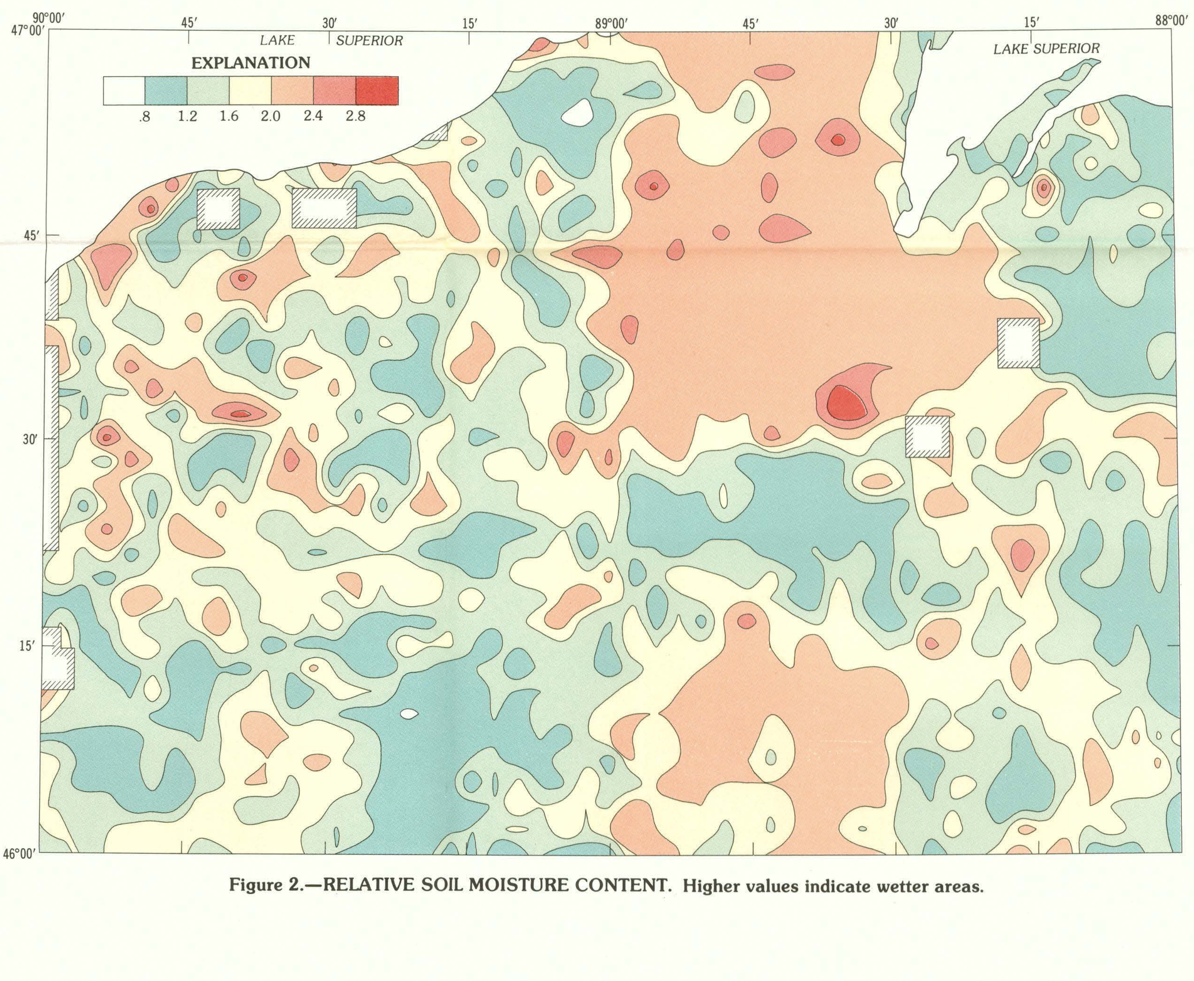

Figure 2.—RELATIVE SOIL MOISTURE CONTENT. Higher values indicate wetter areas.

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SILVER DISTRIBUTION IN B-HORIZON SOILS, IRON RIVER 1° x 2° QUADRANGLE, MICHIGAN AND WISCONSIN

By
R. T. Hopkins, H. V. Alminas, and J. D. Hoffman

1984

For sale by Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202